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(57) An electrically heated device, such as a heating pad, mattress pad or electric blanket, having a heating cable 12 comprising two conductors 24, 26 separated by a layer of positive temperature coefficient material 28 wherein the electrical power supplied to the conductors produces its primary PTC heating effect in the PTC material and the two ends 24a, 24b, 26a, 26b of each of the conductors are connected together and each conductor has means to connect it to one power supply terminal.

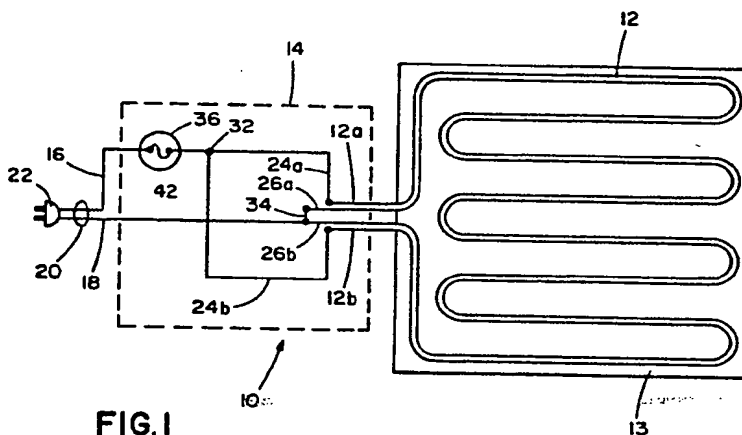


FIG. 1

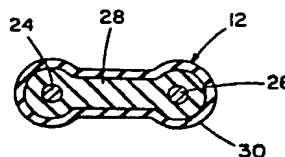
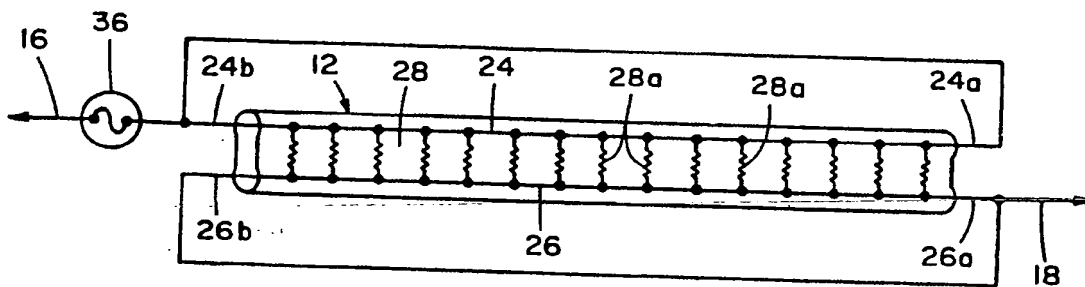
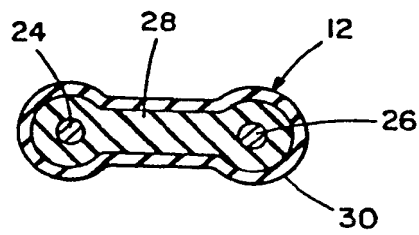
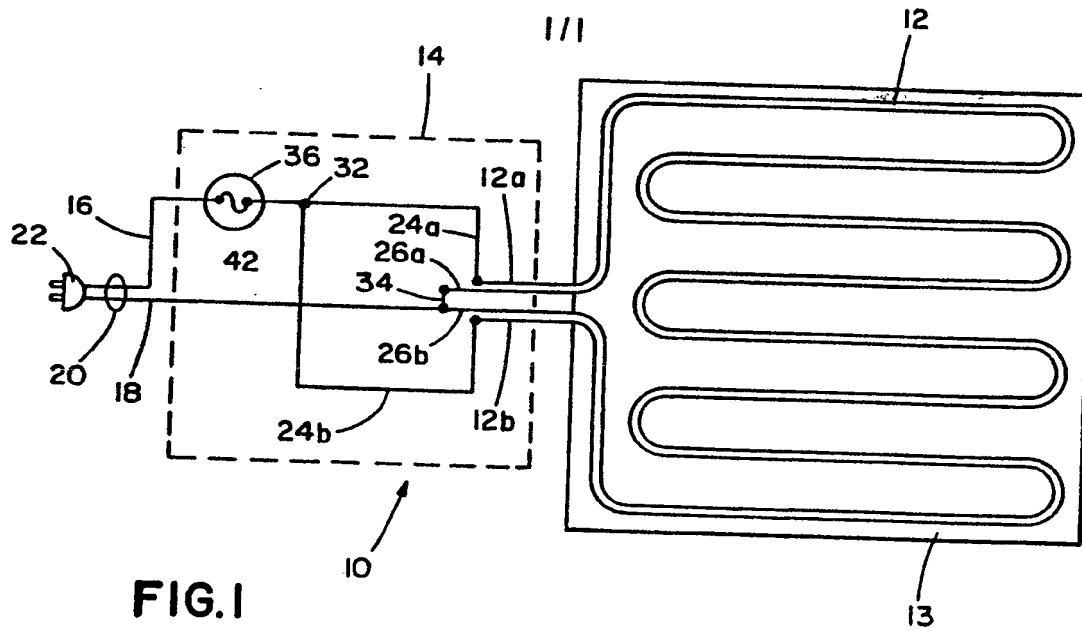


FIG. 2

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SPECIFICATION

Electric blanket or pad

- 5 This invention relates generally to electrically heated devices such as electric blankets, heating pads and mattress pads and, more specifically, to a heating element circuit for use in such blankets and pads.
- 10 Electric blankets, electric mattress pads and heating pads are similar in that all three include some type of elongate flexible heating element which is disposed in a tortuous configuration within a fabric or plastic sandwich
- 15 designed to enclose and obscure the heating element. The fabric or plastic sandwich is sometimes termed a shell and it includes a plurality of passageways through which the heating element is threaded so that the heat
- 20 therefrom is delivered uniformly across the face of the blanket or pad. There are normally a number of spaced lengths of the heating element which are disposed across the surface of the blanket or pad with these portions
- 25 of the heating element being spaced close enough so that when the element is energized the user gets the illusion of more or less uniform warmth across the entire surface of the blanket or pad.
- 30 In the prior art blankets and pads there have typically been some means to control the application of electrical energy to the pad and also means to sense any overheat conditions at local areas in the pad. The local heat sensing is necessary since the control means for the blanket or pad might sense that power is
- 35 required at the same time as an overheat condition exists at some point in the blanket or pad. Such a local overheat condition may be caused by the heating element being folded upon itself or covered by the mattress or a blanket so that temperature tended to increase in that particular area. Where such folding or
- 40 covering of the heating element occurs, the heat is not dissipated from the element at the same speed as in other areas of the blanket or pad and dangerous overheat conditions begin to develop.
- The temperature sensing means to respond
- 50 to such overheat conditions have typically taken the form of bimetallic thermostats positioned throughout the pad or continuous sensing wires which more or less parallel the heating element to sense any overheat conditions throughout the length of the element. A third
- 55 alternative involves the use of a heating element which includes positive temperature coefficient (PTC) material as the heating element. This type of material is self-regulating in that
- 60 increases in local temperature along the length of the heating element cause that portion of the element to receive less current and thereby reduces the power input to the overheated area. There are a number of prior art
- 65 patents disclosing heating element configura-

tions for use in such PTC blankets.

- One of the problems encountered in the prior art PTC heating element circuits is the fact that a break in one of the conductors included in the heating element causes serious arcing at the location of the break and has required that certain safety modules be included in the circuits for such blankets. These safety modules include means for disabling or shutting off the blanket when an open circuit is sensed in either one of the conductors. Since the inclusion of such circuit module to shut off the blanket in the event of an open circuit is expensive, it would be desirable to devise a circuit which would eliminate the necessity for the safety module or safety circuit.

- According to the invention there is provided an electrically heated device comprising an elongate heating element including two spaced conductors separated by a layer of positive temperature coefficient material, said element heating primarily from the I²R heating produced by current passing through said positive temperature coefficient material when said conductors are energized by an electric current, the ends of said element being loop connected together with the two ends of each conductor being connected to a separate power supply terminal.

- 95 With such an arrangement, in the event of a break or open circuit in either of the two conductors in the heating element, there is a relatively small voltage drop across the break since the ends of the broken conductor are connected together. Thus, the only difference in voltage at the break would be a consequence of the location of the break with respect to the ends of the conductor. A break at the middle would produce no drop across the break whereas a break at one end of the conductor would produce a drop equal to the total voltage drop through the length of the conductor which might be on the order of less than 30 volts, preferably less than 10 volts, depending on the resistances of the conductors and the PTC layer. In a preferred embodiment, the resistance of each of said conductors is less than one-sixth of the resistance of the PTC layer disposed between said conductors so that in the event of a break in one of said conductors, the voltage drop at the break will be less than might be required to cause arcing at said break in said conductor.

- Thus it will be seen that by utilizing a positive temperature coefficient heating element which has the ends of its conductors connected together, it is possible to minimize the voltage drop across any break which may occur in either one of the conductors in the cable. Such an arrangement avoids the need for a safety module to interrupt the circuit in the event of an open circuit in one of the conductors.

- Preferably the heating element dissipates on the order of one to four watts per foot. (3,3,

to 13.1 watts/m) when energized by a conventional domestic power supply.

Preferably the heating element comprises a cable disposed in a tortuous manner in the blanket, heating pad or mattress pad. If the device is an electric blanket, then the heating element may be in excess of 100 feet (30.5 m) in length and each conductor might have a total resistance of less than 200 ohms. If the device is an electric heating pad, then the heating element may be on the order of 20 feet (6.1 m) in length and might have a wattage of 3 watts per foot (9.8 watts/m).

The device will normally be used with a cord connector to supply power to each of the two conductors.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

Fig. 1 is a schematic diagram showing an electric blanket in accordance with the invention;

Fig. 2 is a greatly enlarged cross-sectional view of a heating cable of the type used in the blanket of Fig. 1; and

Fig. 3 is a schematic wiring diagram of the blanket of Fig. 1 showing the positive temperature coefficient heating material as a series of distributed parallel resistances.

Referring to the drawings, there is shown in Fig. 1 an electric blanket, heating pad or mattress pad 10. The blanket or pad 10 includes a shell 13 which conventionally consists of several layers of fabric secured together to form passageways through which a heating element 12 is threaded. The element 12 as shown in Fig. 1 is disposed in a tortuous configuration having a plurality of parallel legs interconnected together to dispose the heating element 12 across the entire surface of the shell 13 so that heat is distributed relatively uniformly to the entire surface. The heating element 12 terminates in ends 12a and 12b which extend into a connector module 14 which is shown schematically in greatly enlarged form. The connector module 14 would be no more than a few inches square and would be attached to the blanket 13. Also extending into the connector module 14 are conductors 16 and 18 which form parts of a power cord 20 which terminates in a plug 22.

To better understand the nature of the heating element 12, reference should be had to Fig. 2 which is a greatly enlarged cross-sectional view of the heating element 12. The element 12 includes a pair of spaced conductors 24 and 26 which are separated by a layer of PTC material 28 which also surrounds the conductors 24 and 26 to form a somewhat barbell type configuration. The PTC material 28 is in turn enclosed in an insulating coating 30. The PTC material 28 may be any suitable conductive polymer which exhibits positive temperature coefficient resistance

characteristics at suitable temperatures as is well-known in the art. Possible compositions for the PTC material 28 are disclosed in US Patent 4277673. The conductors 24 and 26 must be of sufficiently high conductivity so that the primary heating effect created in the heating cable 12 is in the PTC material 28 and not in the conductors 24 and 26. Details of the flexible conductors suitable for use in such application are disclosed in US Patent 4309596.

In a typical electric blanket application, the length of the heating element 12 would be on the order of 150 feet (46m) and the voltage drop over the length of one of the conductors 24 or 26 would be on the order of 10 volts when connected to a conventional 110 volt AC power supply. It has been conventional in the past to connect one of the conductors 24 at one end to one side of the power line and the other end of the other conductor to the other side of the power line. The purpose of connecting opposite ends to the opposite sides of the power line is to obtain a uniform potential between the two conductors 24 and 26 throughout the length of the heating element 12. Thus, the heat dissipated at any place along the length of the heating element 12 would be the same. Although less desirable, it is also possible to connect the conductors at one end of the cable 12 to each of the power supply terminals to thereby energize the element 12.

One of the problems which was found to exist with electric blankets using this type of heating element involved the results of having a break in one of the conductors. In such a situation, there would be a substantial voltage drop across the broken ends of the wire, the drop being on the order of 100 volts. This type of voltage drop would cause an arc which had some tendency to dissociate the polymer material into a flammable gas. It was therefore necessary to devise some type of circuit module which would disable the circuit or open the circuit whenever there was a break in one of the conductors which might cause the arcing situation discussed above. An example of one such safety circuit module is disclosed in the U.S. Patent No. 4,436,986. However, such circuit modules tend to be costly and are difficult to justify to the consumer who knows nothing of the need for such a safety module. We have devised a method of connecting the conductors so that the circuit module is rendered unnecessary.

Referring to Fig. 1, the end of the heating element 12a includes conductor ends 24a and 26a and the end 12b includes conductor ends 24b and 26b. Within the module 14, the ends of conductor 24 which comprise 24a and 24b are connected together at 32. The ends of conductor 26 which are designated at 26a and 26b are connected at 34. These common connections 32 and 34 are connected to the

power cord conductors 16 and 18 respectively. There is provided a fuse 36 in series with the cord conductor 16 and the heating element 12.

- 5 Fig. 3 provides a schematic diagram of the circuit described above in connection with Fig. 1. In Fig. 3, the heating element 12 is shown as including the conductors 24 and 26 with a plurality of parallel resistances 28a connected
10 therebetween. The resistances 28a are merely employed to illustrate how the PTC layer 28 would function in the circuit. The I^2R heating produced in the heating element 12 is primarily a result of the current flowing through the
15 PTC material 28 which may be considered an infinite number of parallel resistances connected between the conductors 24 and 26.

The diagram of Fig. 3 shows clearly the loop connection of each of the conductors 24
20 and 26 wherein the ends of each conductor are connected together. In this arrangement, power cord conductor 16 supplies power to both ends of conductor 24 of the heating element 12 and power cord conductor 18 supplies power to both ends of the conductor
25 26. As a consequence, if either of the conductors 24 or 26 breaks and opens the circuit at some particular point over its length, there will be a minimal voltage drop at the break
30 because both segments of the broken conductor will still be connected to the power supply. If the break is in the middle of the conductor, there will be no voltage drop while if it were at one end there would exist whatever
35 drop occurred over the length of the longer conductor which would only be about 10 volts.

In contrast with only one end of each conductor connected to the power supply, a
40 break in one of the conductors will result in a voltage drop across the break of about 100 volts since the unpowered end of the conductor away from the break tends to assume the voltage of the other side of the line giving
45 almost full line voltage across the break.

As is evident from Fig. 1, the ends of each conductor 24 or 26 are close together making it a simple matter to complete the loop connection. The resulting circuit, in which the
50 heating element is connected to be supplied with power from both ends, provides a simple and effective means of overcoming the very serious arcing problem which existed with respect to the prior art PTC blankets.

55 Modifications to the broad aspects and the specific embodiment of the invention may be apparent to a skilled person and the disclosure hereof is intended to encompass such modifications.

60 CLAIMS

1. An electrically heated device comprising an elongate heating element including two-spaced conductors separated by a layer of
65 positive temperature coefficient material, said

element heating primarily from the I^2R heating produced by current passing through said positive temperature coefficient material when said conductors are energized by an electric current, the ends of said element being loop connected together with the two ends of each conductor being connected to a separate power supply terminal.

2. A device as claimed in claim 1, wherein
75 the resistances of said conductors and of said positive temperature coefficient material layer are selected such that when said power supply is a conventional domestic electric power supply and a break occurs in either of said
80 conductors, the resulting voltage across the break is less than thirty volts, thereby producing minimal arcing at said break.

3. A device as claimed in claim 1, wherein the resistance of each of said conductors is
85 less than one-sixth of the resistance of the PTC layer disposed between said conductors so that in the event of a break in one of said conductors, the voltage drop at the break will be less than might be required to cause arcing at said break in said conductor.
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4. A device as claimed in claim 1, 2 or 3, wherein said element dissipates on the order of one to four watts per foot (3.3 to 13.1
95 watts/m) when energized by a conventional domestic power supply.

5. A device as claimed in any preceding claim, being an electric blanket having said element disposed in a tortuous configuration in a fabric blanket shell, said element being in
100 excess of 100 feet (30.5m) in length and each said conductor having a total resistance of less than 200 ohms.

6. A device as claimed in any of claims 1 to 4, being an electric heating pad having said
105 element disposed in a tortuous configuration in a flexible envelope, said element being on the order of 20 feet (6.1m) in length and having a wattage of on the order of 3 watts per foot (9.8 watts/m).

7. A device as claimed in any of claims 1 to 4, wherein said heating element is supported by a flexible envelope with said element in a tortuous configuration, said envelope being formed to be disposed in a planar
110 configuration with the element being arranged to supply heat uniformly across the surface of said envelop.

8. A device as claimed in claim 6, wherein said envelope comprises a generally rectangular configuration with said heating element
120 ends being disposed in the middle of one edge of said rectangle, the element being arranged in a plurality of interconnected parallel legs which extend generally perpendicular to said one edge, and the element having portions extended along said edge from said middle to the outer most of said parallel legs.

9. A device as claimed in any preceding claim, wherein said heating element is disposed with its ends being disposed adjacent
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to each other so that said conductor ends may be connected directly together.

10. A device as claimed in any preceding claim, wherein the positive temperature coefficient material extends between said conductors and envelops said conductors.

11. A device as claimed in any preceding claim, wherein said heating element is throughout its length spaced from other portions thereof except at the ends where said conductors are interconnected together.

12. An electrically heated device substantially as hereinbefore described with reference to the accompanying drawings.

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